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IS 1528 (Part 12) : 2007
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उष्मासह सामग्रियों के नमूने लेने की और भौतिक परीक्षण पद्धतियाँ

भाग 12 आकारित उष्मारोधी अग्निसह उत्पाद के बल्क घनत्व और वास्तविक सरन्ध्रता ज्ञात करने की पद्धति

(दूसरा पुनरीक्षण)

Indian Standard

METHODS OF SAMPLING AND PHYSICAL TESTS FOR REFRACTORY MATERIALS

PART 12 METHOD FOR DETERMINATION OF BULK DENSITY AND TRUE POROSITY OF SHAPED INSULATING REFRACTORY PRODUCTS

(Second Revision)

ICS 81.080

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 2007

Price Group 2

Refractories Sectional Committee, MTD 15

NATIONAL FOREWORD

This Indian Standard (Part 12) (Second Revision) which is identical with ISO 5016 : 1997 'Shaped insulating refractory products — Determination of bulk density and true porosity' issued by the International Organization for Standardization (ISO) was adopted by the Bureau of Indian Standards on the recommendation of the Refractories Sectional Committee and approval of the Metallurgical Engineering Division Council.

This standard was originally published in 1962 and subsequently revised in 1972. This revision of the standard has been taken up to align it with ISO 5016 : 1997 by adoption, under dual numbering system.

The text of ISO Standard has been approved as suitable for publication as an Indian Standard without deviations. Certain conventions are, however, not identical to those used in Indian Standards. Attention is particularly drawn to the following:

a) Wherever the words 'International Standard' appear referring to this standard, they should be read as 'Indian Standard'.

b) Comma (,) has been used as a decimal marker, while in Indian Standards, the current practice is to use a point (.) as the decimal marker.

In this adopted standard, reference appears to certain International Standards for which Indian Standards also exist. The corresponding Indian Standards, which are to be substituted in their places, are listed below along with their degree of equivalence for the editions indicated:

International Standard	*Corresponding Indian Standard*	*Degree of Equivalence*
ISO 5017 : 1988 Dense shaped refractory products — Determination of bulk density, apparent porosity and true porosity	IS 1528 (Part 15) : 2007 Methods of sampling and physical tests for refractory materials: Part 15 Method for determination of bulk density, apparent porosity and true porosity of dense shaped refractory products (*first revision*)	Identical
ISO 5018 : 1983 Refractory materials — Determination of true density	IS 1528 (Part 9) : 2007 Methods of sampling and physical tests for refractory materials: Part 9 Determination of true density (*fourth revision*)	do

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

Indian Standard

METHODS OF SAMPLING AND PHYSICAL TESTS FOR REFRACTORY MATERIALS

PART 12 METHOD FOR DETERMINATION OF BULK DENSITY AND TRUE POROSITY OF SHAPED INSULATING REFRACTORY PRODUCTS

(Second Revision)

1 Scope

This International Standard specifies a method for the determination of the bulk density and true porosity of shaped insulating refractory products.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 5017:—1), *Dense shaped refractory products — Determination of bulk density, apparent porosity and true porosity.*

ISO 5018:1983, *Refractory materials — Determination of true density.*

3 Definitions

For the purposes of this International Standard, the following definitions apply.

3.1 bulk density, ρ_b **:** Ratio of the mass of the dry material of a porous body to its bulk volume.

3.2 bulk volume, V_b **:** Sum of the volumes of the solid material, the open pores and the closed pores in a porous body.

NOTE — The roughness of the surface limits the accuracy of definition of the bulk volume and, in consequence, the bulk density. Also, the notion of bulk density becomes less precise when the volume of the sample diminishes below certain limits or when its texture (size of pores and grains) is too coarse.

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1) To be published. (Revision of ISO 5017:1988)

3.3 true density, ρ_t : Ratio of the mass of the solid material of a porous body to its true volume.

3.4 true volume : Volume of the solid material in a porous body.

3.5 open pores : Those pores that are penetrated by the immersion liquid in the test specified in ISO 5017.

NOTE — These pores are, in principle, all those that are connected with the atmosphere, either directly or via one another. Here also the roughness of the surface imposes a limit to the accuracy of the definition of the volume of the open pores.

3.6 closed pores : Those pores that are not penetrated by the immersion liquid in the test specified in ISO 5017.

3.7 true porosity, π_t : Ratio of the total volume of the open pores and the closed pores in porous body to its bulk volume.

3.8 shaped insulating product : Shaped product having a true porosity of not less than 45 % (*v/v*).

4 Principle

The mass of a dry test piece of a specified geometrical form is determined by weighing and the dimensions are measured. From these values and from the true density of the material, (determined by the method specified in ISO 5018, the volume, bulk density and true porosity are determined by calculation.

NOTE — The method of immersion in a liquid and determination of the mass of the test piece when immersed and when soaked is not suitable for insulating refractory products because of their very open texture, which can lead to serious errors in the determination of the mass of the test piece when soaked.

The precision of the results does not require any correction to be made for the fact that weighing is carried out in air, not in a vacuum.

5 Apparatus

5.1 Callipers, graduated in 0,5 mm, or **flat metal rule**, graduated in 0,5 mm and having a square at one end which can be fitted to the edge of the test piece.

5.2 Drying oven, capable of being controlled at (110 ± 5) °C.

5.3 Balance, with an accuracy of ± 0,1 g.

5.4 Desiccator.

6 Test pieces

6.1 The number of items (for example, bricks or blocks) to be tested shall be determined by agreement between the interested parties.

6.2 If several items are tested, the same number of test pieces shall be taken from each item, so as to facilitate statistical calculation.

NOTE — The number of test pieces per item should be the subject of agreement between the interested parties.

6.3 The test pieces shall be rectangular with plane and parallel surfaces. The volume of each test piece shall be not less than 500 cm^3 and no dimension of a test piece shall be less than 50 mm. The faces of each test piece shall be precisely formed to obtain a parallelepiped. For the purposes of this test, the test piece shall be considered to be a parallelepiped if, for each pair of opposite faces, the four measurements made along the centre lines of the faces that separate them do not differ by more than 1,0 mm.

6.4 In the case of insulating bricks that have been finished by sawing, the whole brick may be used as a test piece, provided that the faces are plane and parallel, the parallelism tolerance being as specified in 6.3.

7 Procedure

7.1 Using the callipers or the flat metal rule (5.1), measure the three principal dimensions (length l, breadth b, thickness d) of each test piece to within 0,5 mm. The measurements shall be made at the centre line of each face (i.e. four times for each dimension) and the mean of the four measurements shall be noted for each of the three dimensions.

7.2 Dry the test pieces carefully in the drying oven (5.2), controlled at (110 ± 5) °C, allow to cool to ambient temperature in the desiccator (5.4), and weigh each test piece to the nearest 0,1 g.

7.3 Repeat the drying, cooling and weighing operations until constant mass is reached, i.e. until two successive weighings made before and after at least 2 h in the drying oven do not differ by more than 0,1 %.

7.4 Determine the true density in accordance with ISO 5018.

8 Expression of results

8.1 The bulk volume V_b of the test piece is given, in cubic centimetres, by the equation

$$V_b = lbd$$

where l, b and d are the length, breadth and thickness, respectively, in centimetres, of the test piece.

8.2 The bulk density ρ_b of the test piece is given, in grams per cubic centimetre, by the equation

$$\rho_b = \frac{m}{V_b}$$

where

m is the dry mass, in grams;
V_b is the bulk volume, in cubic centimetres.

8.3 The bulk density shall be expressed in grams per cubic centimetre or in kilograms per cubic metre (by multiplying the result in 8.2 by 10^3). The calculation shall be made to three significant digits.

8.4 The true porosity π_t is given, as a percentage, by the equation

$$\pi_t = \frac{\rho_t - \rho_b}{\rho_t} \times 100\,\%$$

where

ρ_t is the true density of the product, in grams per cubic centimetre, determined in accordance with ISO 5018;

ρ_b is the bulk density, in grams per cubic centimetre (see 8.2).

8.5 The calculation of the true porosity shall be made to the nearest 0,1 %.

9 Test report

The test report shall include the following information:

a) the name of the testing establishment;

b) the date of the test;

c) reference to this International Standard, i.e. "Determined in accordance with ISO 5016";

d) the designation of the material tested (manufacturer, type, batch number);

e) the number of test pieces per item; alternatively a statement that a whole brick was used (see 6.2 and 6.4);

f) the individual values and the mean value of the bulk density and true porosity for each item.

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